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TEST OF 1800 POUND PONTOON, THE PROTOTYPE OF THE 40 TON MODEL

6 JANUARY 1948

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U. S. NAVY EXPERIMENTAL DIVING UNIT

NAVAL GUN FACTORY

WASHINGTON, D. C.

Project no. - SRD 1425/48

Title - Test of 1800 Pound Pontoon, the Prototype of the 40 ton Model

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Commander, USN
Officer in Charge

OBJECT OF TEST

The object of this experiment is to test a rated 1800 pound rubber nylon pontoon with regard to its structural strength, durability, ease of handling and maximum load, and to determine its characteristics under various loads and conditions. The results are to be used as a basis for the construction of a 40 ton pontoon of the same type.

METHOD

The pontoon tested, was a rated 1800 pound rubber nylon pontoon manufactured by the Goodyear Tire and Rubber Company, Akron, Ohio. It is a prototype of a 40 ton pontoon. The pontoon had light wires running from the load ring along the periphery and joining together at the top. The air hose connection was 1/4 inch and it was located just off center. Oxygen hose, 3/16 inch inside diameter, was used for blowing. The air supply was 90 lb/in^2. A toe and a valve open to the air was fitted to the pontoon to facilitate venting. About 100 feet of hose was used.

All tests were performed at the Naval Ordnance Tank, Navy Yard, Washington, D.C. The tank is 25 feet in diameter and is 60 feet deep. The bottom is covered with a 5 foot layer of coarse gravel. The water was fresh and fairly clean.

The weights used were parts of steel billets with smaller steel and lead weights used to make the desired weight combinations. Both deep sea and shallow water diving outfits were used. In latter tests, the pontoon was lifted out of the water by the overhead hoist and the desired weight combinations made topside.

All tests were performed with a total lift of about 50 feet with the pontoon attached as close to the weights as possible.

Canvas skirts of various designs were used in tests number 5 through number 22. Tests number 17 through number 22 were made with the skirt inside the shrouds. There was no opening in the bottom. Tests number 5 through number 16 were made with the skirt on the outside of the pontoon with various bottom openings.

The dimensions of the respective skirts are given in the data remarks. Tests number 23 through number 25 were carried out with a 3/16 inch steel plate 30 inches in diameter at various distances below the skirt. The plate weighed 25 pounds and had 12 slots to accommodate the shrouds. Tests number 1 through number 4 are covered by the memorandum to BuShips of 27 October 1947 S94(20). Test number 26 was carried out with the pontoon without any appurtenances.

In all tests the conditions for the run are enumered on the data sheet of the heaviest weight.

DISCUSSION OF RESULTS

The pontoon remained afloat after surfacing in all tests except when the 1809 pound load was used. This was just 41 pounds under maximum capacity. The maximum capacity is 1850 pounds. It sunk about 50% of the time at this load. The use of the skirt did not alter this characteristic. The pontoon was kept afloat in every instance when air was blown in to the pontoon upon surfacing at this load. In all data shown, the air supply was closed after the pontoon started to rise. The use of a skirt did not decrease the velocity of the pontoon.

In all tests, it was shown that the less the load, the greater the velocity of ascent. The greatest unbalanced force is that of the displacement of the pontoon over the weight of the object to be lifted. There is a jet effect but it does not seem to produce a noticeable effect. This was shown by the comparison of runs with skirts of various dimensions. It is agreed that this effect could be minimised by the exhausting of air from the side, but the overall effect is small. If the opening is cut down too much, the building up of pressure inside the pontoon will cause it to expand thus increasing the unbalanced force, as well as increasing the tendency of the fabric to rupture. Moreover, the skirt presents obvious technical difficulties in operation, construction and upkeep. These results are corroborated by the tests on the 15 ton pontoon.

The pontoon emerged from 1 foot to 3.5 feet out of the water upon surfacing. It emerged out of the water about 1 foot with the 1809 pound net weight and a maximum of about 3.5 feet with the 870 pound net weight. At no time was there any loss of air. This was shown by blowing air into the pontoon at equilibrium conditions. Air was exhausted immediately.

The shape of the pontoon varies with the load. At light load it tends to assume a spherical shape. At heavy loads, its shape approaches that of a tear drop. The maximum diameter of the pontoon is about 4 feet.

The vent time would have been excessive if a valve were not fitted for venting next to the pontoon. There were no structural failures. Except for three small leaks along the seams caused probably by faulty cementing, the fabric was in good condition. It was rather difficult to handle as it had no "Dee" rings.

It is to be expected that the maximum speed will increase with an increase in pontoon size. The only force counteracting the unbalanced force is the frictional resistance. The maximum speed is important since it causes the pontoon to emerge past its normal at rest position upon surfacing. The velocity of the pontoon going down is not much less than going up. Since it possesses considerable kinetic energy at this point, work must be done on it to bring it to a stop before it reaches the critical depth in its descent. This depth is defined as the point at which the displacement in the pontoon is equal to the weight lifted. Frictional force accomplishes part of this work, but it decreases almost as the square of the velocity. The greatest part of this work

necessary to stop the pontoon must be done by the excess buoyant volume.

Since the volume of a shphere changes twice as fast as the area of its surface, as its diameter is changed, it will be seen that the speed will increase with larger pontoons. It is to be noted that the test conditions in respect to the water resistance of the load are the most unfavorable that could be encountered. The surface of a submerged vessel would present a much greater area for water resistance to act on with an accompanying reduction in velocity than do the metal weights used in these tests.

It should be emphasized that the load characteristics of a small prototype would be considerably different from that of a large size pontoon. The biggest deviation is that of the expected increase in speed of the larger one when lifting an object of relatively little water resistance. In lifts of this sort, it is expected that an excess buoyancy of about 25% or perhaps more is needed to check the pontoon's descent before its critical depth is reached.

To anticipate the action of various sizes of pontoons, it is necessary to recognize the forces acting on the pontoon in the vicinity of the datum line. The latter is defined as the horizontal line passing through the center line of the center of gravity of the weights when the pontoon is floating at equilibrium conditions. In ascent, the weights are moving past this point at their maximum velocity. This velocity is determined by the buoyant unbalanced upward force of the pontoon over the mass of the weights, the opposing friction of the pontoon and weights through the water, and the depth. In our case, the maximum possible velocity probably was never reached since the distance was never great enough to accelerate the pontoon to its utmost. In the 1807 pound and 1625 pound net loads, the maximum velocity may have been approached.

If we refer to the equation of the resistance of a ship through water, we will see that the frictional resistance is roughly equal to the square of the velocity: $R_f = f\,S\,V^{1.85}$

R_f = Frictional force in pounds.

f = Coefficient, varies from .012 to .020.

S = Wetted surface in square feet

V = Speed in knots; 1 knot = 1.68/ft/sec

In the above equation, eddy and wave making resistance in neglected although they are quite prominent at the surfacing on the pontoon. The coefficeint "f" would in our case be higher. Eddy resistance also varies as roughly the square of the speed. Wave resistance is negligible at low speeds.

We can assume that the maximum velocity is roughly equal to the average multiplied by 2. If we compare the results of the 1627 pound weight and the 870 pound weight test, we have found that the time required for an ascent is roughly 10 seconds and 7.5 seconds respectively. With the halving of the unbalanced force, the velocity increases about one quarter. This would show that the frictional resistance is roughly equal to the square of the velocity multiplied by a constant.

Attention is invited to the fact that the above analysis of the force system is rough and is not to be construed as an exact experiment. The determination of the frictional force, wave and eddy effects are beyond the scope of these tests. However, they do show whether the forces involved are linear or exponontial. In the analysis of the force system in the vicinity of the datum line, it was felt that treatment of the problem by analysis of the kinetic and potential energies would be most applicable.

At the datum line in ascent and descent, the kinetic energy = $1/2\ m\ V^2$. Thus, work equal to $1/2\ mV^2$ must be done on the weights before they can be stopped. This work is accomplished by two forces. The first is friction, eddy and wave making resistance. The second and greater is the maximum downward force of gravity divided by 2 acting through a distance the pontoon rises above the datum line. This downward force of gravity at its maximum is equal to the displacement of that portion of the pontoon that comes out of the water above equilibrium conditions. It is zero at equilibrium and hence the average force is the maximum divided by two.

When the pontoon is at the peak of its ascent, it has acquired potential energy equal to the average force of gravity multiplied by the distance above the datum line. Potential energy = W h, where "W" is the weight and "h" is the height.

When the weights are again at the datum line in their descent, this potential energy has been translated again into kinetic energy. It the 1627 pound weight were descending at a velocity of 5 ft/sec at the datum line, the following work would have to be done on it to stop it:

$$K.E. = 1/2\ m\ V^2 = \frac{1627.5^2}{2\ ,\ 32} = 625 \text{ ft. lbs.}$$

Critical depth assuming bottom of pontoon is 3 feet below water line and capacity of pontoon is 1850 pounds.

$$\text{Critical depth} = 36 \cdot \frac{1850}{1627} = 41 \text{ ft. absolute.}$$

Work capable of being performed by excess buoyant volume = force x distance = $\frac{(1850 - 1627)}{2}$ (41 ft. - 36 ft.) = 111.5 x 5 = 557.5 ft. lbs.

This above value of work would not stop the pontoon if it were not for the work done by the frictional force.

Therefore: 625 - 557.5 = 67.5 ft. lbs. is the minimum work that must be done by friction if the pontoon is to stay up.

However, all the potential energy has not changed into kinetic energy since some of it was absorbed by friction, eddy and wave making. Therefore, the kinetic energy of the mass in its descent is equal to the kinetic energy of its ascent minus the energy of friction, eddy and wave making in its ascent and descent above the datum line. If the latter were not present, the velocity and kinetic energy at descent and ascent would be equal.

At any rate, the kinetic energy at descent would still be considerable. It is doubtful that more than 25% of the kinetic energy is taken by friction, eddy and wave making.

Therefore, it is necessary that work equal to the descent kinetic energy be done on the weights and pontoon before they reach the critical depth. The critical depth is the depth at which the displaced volume of the pontoon is equal to the net weight. It increases inversely as the load. Work is done on the weight system by two forces. First in importance is the work done by the excess buoyant volume of the pontoon above the displacement of the weight. It is at its maximum at the point where the pontoon is just below the water and zero at the critical depth. The second force is that of friction which diminishes rapidly as it decreases approximately as the square of the velocity.

With a larger pontoon the velocity would increase since the surface varies as the square and the volume and therefore the unbalanced force as the cube. Since the velocity increases, the kinetic velocity would increase as the square of the velocity. Thus if the velocity is doubled, the work to be done on the pontoon in its descent would increase four times. The greatest part of this work must be done by the excess buoyant volume since the frictional resistance force does not increase coequally with the volume of the pontoon. For this reason, the tonnage rating of a pontoon is ambiguous when this effect is not taken into account. The pontoon when used alone may lift a load but will fail to keep it surfaced. This effect will be accenturated by a larger pontoon, deeper depth from which a load is raised and the density of the object

It is felt that in certain types of lifts with the use of pontoons only, the sinking of the load upon surfacing is often attributed erroneously to the loss of air upon surfacing. In none of these tests, has this been true. Little if any air has been lost although at times the pontoon was at least 75% out of the water. In trials where the depth and load have been great enough to blow the pontoon clean prior to surfacing, when air was blown into the pontoon, it was exhausted almost immediately from the bottom. With the use of the 1325 pound weight, the bubbles and the pontoon surfaced simultaneously. In all weights under this, the pontoon preceded the bubbles. It is conceivable that at lighter loads, there may be a pocket of air under the pontoon as it reaches the surface. When the pontoon is in its descent, it may pick up some of this air.

It is felt that the jet effect of the pontoon is not of great improtance. There is no discernible difference between the velocities of the pontoon with or without such appurtenances as skirts or plates. The addition of the latter with the near capacity load seemed to have a greater incidence of sinkings than when the pontoon was used without it. Moreover, the handling of a similar plate in underwater hook ups is objectionable.

Test number 22 was made with a 50 pound overlead to simulate a situation where the controlling lift was made by other means. It was successful. Great care must be taken that this is done slowly. If lifted too fast, the momentary expansion of the pontoon will tend to accelerate the load with an accompanying gain in velocity. It would then stop and start sinking rather rapidly since the buoyant volume is decreasing. Even if one is able to raise it fast, there is still the kinetic energy to reckon with in its descent. In this case nearly all the work done to check this fall must be done by external work, since the excess buoyant volume is zero. It was also shown that the jet effect is not considerable. When air was blown into the pontoon, there was no noticeable difference in the force required to lift the 50 pound excess load. Also when air was blown into it when afloat, it would sink unless held up by external means.

It is to be noted that in the use of the 435 pound weight, there is an apparent anomaly in our contention that the speed increases with the decrease in load. This is due to the lack of sufficient depth for the original volume to expand to its maximum volume. In this case, with the 50 foot depth, the maximum unbalanced force is 735 pounds, the average being the latter value divided by 2.

In all tests with skirts, it was rather difficult to estimate the size of the opening with respect to the original.

CONCLUSIONS

The pontoon was structurally satisfactory. The shrouds were in good shape and showed no signs of failure.

The fabric except for three small leaks was satisfactory.

The failure of the pontoon to remain afloat with near capacity loads is due to the lack of excess buoyant volume of the pontoon to counteract the kinetic energy of the weights in their descent before the critical depth is reached.

The sinking was not caused by the loss of air upon surfacing. None of the tests indicated loss of air upon emergence. However, the loss of air is a possibility at greater terminal velocities and during other conditions not encountered in these tests.

The sinking at near capacity loads is due to a great extent on the velocity. This velocity is caused by the unbalanced force of the excess buoyant volume of the pontoon and the reaction or jet effect. The latter is considered not too important as was shown by skirts and other appurtenances which tended to cancel the effect by side exhaustion.

The only force opposing these two forces is the frictional and possibly eddy resistance. These are directly proportional to the wetted surface. If pontoons are used in lifting loads of great density, it is expected that the velocity will increase with size since the surface area varies as the square and volume as the cube. For this reason, load characteristics of a small pontoon will be considerably different from similar pontoons of larger size. The most improtant difference is the velocity increase of the larger size with an accompanying increase in kinetic energy.

It is felt that load ratings of pontoons and especially those of larger sizes should be specified for definite conditions. A 40 ton pontoon will lift 40 tons, but may not be able to keep afloat a greater load than 30 tons if the lift is from a considerable depth, and if the load has a high density and hence little frictional resistance. Sinking of such loads subsequent to surfacing may be often erroneously attributed to loss of air rather than the failure of the force system to counteract the kinetic energy of the descent.

The lifting of a load with pontoons and the controlling lift made by external means is feasible. Care must be taken that the lift is not made too fast.

The gereral design and performance of this prototype is satisfactory and a larger type should meet the structural and ease of handling requirements.

The use of a large pontoon for raising loads in the vicinity of one quarter dead load capacity is practical. If the depth is not too great, the speed of ascent will not be excessive. This was shown in the test run with a 435 pound load.

The pontoon was rather difficult to handle since it had no rings. In a larger type of pontoon, it would be desirable to have handling rings attached to a strength member such as one of the shrouds rather than to the fabric.

As with other types, the air connection was again too small. A larger connection can always be reduced but the converse is not true. Venting is always a problem with an undersize connection.

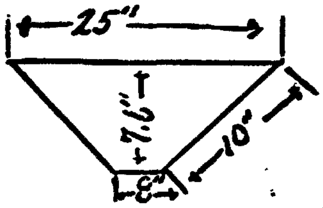
TEST #5

31 October 1947

WEIGHT (gross): 2070; (net): 1809

Dist top of pontoon to w.l. prior blowing	50 f.	50 f.	50 f.	50 f.
Inflation time	1 m. 35 s.	1 m. 35 s.	1 m. 30 s.	1 m. 30 s.
Time of ascent	17 s.	15 s.	17 s.	17.5 s.
Time required for vent	30 s.	30 s.	30 s.	
Time of descent	9 s.	8 s.	8 s.	Sunk
Approx. max. distance bolloon out of water on surfacing	About 1 f.	1.5 f.	1 f.	1 f.

Remarks:
Used with skirt. Bubbles preceded pontoon emergence. Valve at pontoon to facilitate venting. Skirt open at bottom fitted outside of shrouds. It was made of canvas and was secured to the shrouds.



Area of 12 openings - 118 in^2, assuming half circle 5 in diam
Area of bottom openings = πr^2 = 3.14 · 16 = 50.24 in.
Area of original opening = $\pi\ 12.5^2 = 475\ in^2 = A_1$
Area of all openings = 168 in^2

$$\frac{A_1}{A_2} = \frac{475}{118 + 50} = 2.9$$

31 October 1947 TEST #6

WEIGHT (gross): 1870; (net): 1627

Dist. top of pontoon to w.l. prior blowing	50 ft.	50 ft.	50 ft.
Inflation time	2 min. 5 s.	1 min. 20 s.	1 min. 20 s.
Time of ascent	9.5 s.	10 s.	10.5 s.
Time required for vent	1 min. 30 s.	1 min. 25 s.	1 min. 30 s.
Time of descent	11.5 s.	8.5 s.	9 s.
App.max.dist.balloon out of water surfacing	2 f.	2 f.	2.5 f.

Remarks:
Bubbles preceded pontoon

TEST #7

31 October 1947
WEIGHT (gross): 1600; (net): 1325

Dist. top of pontoon to w.l. prior blowing	50 f.	50 f.	50 f.
Inflation time	1 min. 4 sec.	1 min. 30 sec.	1 min. 30 sec.
Time of ascent	9 sec.	8.5 sec.	8.5 sec.
Time required for vent	3 min.	2 min. 30 sec.	2 min. 25 sec.
Time of descent	10 sec.	10.5 sec.	10 sec.
Approx. max. distance balloon out of water on surfacing	3 f.	2.5 f.	3 f.

Remarks:
Bubbles and pontoon surfaced simultaneously

Excess air escaped but pontoon was blown clean.

TEST # 8

31 October 1947
WEIGHT (gross): 1000; (net): 870

Dist. top of pontoon to w.l. prior blowing	50 ft.	50 ft.	50 ft.
Inflation time	45 sec.	45 sec.	45 sec.
Time of ascent	8 sec.	8 sec.	8.5 sec.
Time required for vent	5 min. 25 sec.	5 min.	5 min.
Time of descent	12 sec.	12 sec.	11 sec.
Approx. max. distance balloon out of water on surfacing	3.5 ft.	3.5 ft.	3.5 ft.

Remarks:
No effective air lost after surfacing as air was expelled immediately upon blowing. Tilted as it came out of water

Tilted as it came out. Lost little if any, air

TEST # 9

31 October 1947
WEIGHT (gross): 500; (net): 435

Dist. top of pontoon to w.l prior blowing	50 ft.	50 ft.	50 ft.
Inflation time	35 sec.	25 sec.	22 sec.
Time of ascent	8 sec.	8.5 sec.	9 sec.
Time required for vent	4 min. 30 sec.	5 min. 20 sec.	
Time of descent	14 sec.	14 sec.	
Approx. max. distance balloon out of water on surfacing	3.5 ft.	3.5 ft.	
Remarks: 18 in. from top to w.l. at equilibrium conditions. Diam. 48 in. 28 in. from top to w.l. when blown chean. Diam. 54 in.		Lost little if any air	Lost some air, but there was plenty reserve

TEST # 10

4 November 1947
WEIGHT (gross): 2070; (net): 1809

Dist. top of pontoon to w.l. prior blowing	51 ft.	51 ft.	51 ft.	51 ft.
Inflation time	2 min. 35 sec.	1 min. 7 s.	1 m. 27 s.	1m. 30s.
Time of ascent	16.5 sec.	17.5 sec.	18.5 sec.	20 sec.
Time Required for Vent	-	1 m. 20 s.	1 m. 20 s.	
Time of descent	Sunk	10 sec.	10 sec.	
Approx. max. distance balloon out of water on surfacing	1 ft.	1 ft.	1 ft.	

Remarks: Same skirt as in preceding tests. Bottom diameter reduced to 4 in. Area 12 openings - 118 in.^{2} Area of 4 in. diam. open. 12 in.^{2}. Orig. area of opening - 130 sq in. = 475 m^2 $\frac{A1}{A3} = \frac{475}{130} = 3.65$

TEST # 11

4 November 1947
WEIGHT (gross): 1870; (net): 1627

Dist. top of pontoon to w.l. prior blowing	51 ft.	51 ft.	51 ft.	51 ft.
Inflation time	1 m. 20 s.	1 m. 20 s.	1 m. 20 s.	1 m. 20 s.
Time of ascent	13 s.	10.5 s.	10.5 s.	10.5 s.
Time required for vent	1 m. 30 s.	1 m. 12 s.	1 m. 15 s.	
Time of descent	10 s.	10.5 s.	10 s.	
Approx. max. distance balloon out of water on surfacing	2 ft.	1.5 ft.	2 ft.	

TEST # 12

4 November 1947
WEIGHT (gross): 1500; (net): 1327

Dist. top of pontoon to w.l. prior blowing	50 ft.	50 ft.	50 ft.	50 ft.
Inflation time	1 m. 15 s.	1 m.	1 m. 3 s.	1 m. 2 s.
Time of ascent	7.5 s.	7 s.	7 s.	7 s.
Time required for vent	3 m.	2 m. 35 s.	2 m. 30 s.	
Time of descent	10.5 s.	10 s.	12 s.	
Approx. max. distance balloon out of water on surfacing	2.5 ft.	2.5 ft.	2 ft.	2.5 ft.

TEST # 13

4 November 1947
WEIGHT (gross): 1000; (net): 870

Dist. top of pontoon to w.l. prior blowing	50 ft.	50 ft.	50 ft.	50 ft.
Inflation time	45 s.	1 m.	45 s.	45 s.
Time of ascent	8,5 s.	7.5 s.	9 s.	8 s.
Time required for vent	5 m.	5 m. 40 s.	6 m.	
Time of descent	11 s.	11 s.	11 s.	
Approx. max. distance balloon out of water on surfacing	3 ft.	3 ft.	3 ft.	3.5 ft.
Remarks:	Could see skirt. No air lost. Came out Sideways	Could see skirt. No air lost. Came out sideways	Came Straight up.	-

TEST # 14

4 November 1947
WEIGHT (gross): 500; (net): 435

Dist. top of pontoon to w.l. prior blowing	50 f.	50 f.	50 f.	50 f.
Inflation time	42 s.	23 s.	24 s.	24 s.
Time of ascent	9 s.	10 s.	9.5 s.	9.5 s.
Time required for vent	4 m. 45 s.	5 m. 6 s.	4 m. 5 s.	
Time of descent	11 s.	13 s.	11.5 s.	
Approx. max distance balloon out of water on surfacing	2.5 ft.	2.5 ft.	2.5 ft.	

Remarks:
18 in. above w.l. at equilibrium.
26 in. above w.l. blown clean

TEST # 15

6 November 1947
WEIGHT (gross): 2070; (net): 1809

Dist. top of pontoon to w.l. prior blowing	50 ft.	50 ft.	50 ft.	50 ft.
Inflation time	3 m.	1 m. 26 s.	1 m. 25 s.	1 m. 22 s.
Time of ascent	16 s.	18 s.	19 s.	17 s.
Time required for vent	45 s.			
Time of descent	11 s.	Sunk	Sunk	
Approx, max. distance balloon out of water on surfacing	1 f.			1 ft.

Remarks: Same skirt is used, closed at the bottom. Skirt was open between bottom of pontoon and top of skirt. Top of skirt was fastened to every second shoud. Opening is roughly 200 sq. inches.

Pontoon was near side of tank when it sunk.

TEST # 16

6 November 1947
WEIGHT (gross): 1870; (net): 1627

Dist. top of pontoon to w.l. prior blowing	50 ft.	50 ft.	50 ft.	50 ft.
Inflation time	1 m. 25 s.	1 m. 25 s.	1 m. 25 s.	1 m. 22 s.
Time of ascent	11 s.	12 s.	12 s.	11 s.
Time required for vent	1 m. 10 s.	1 m.	1 m. 25 s.	
Time of descent	10 s.	11 s.	11 s.	10 s.
Approx. max. distance balloon out of water on surfacing	1.5 f.	1.5 f.	1.5 f.	1.5 f.

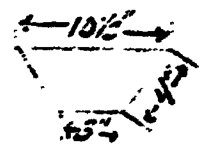
Remarks: Skirt was ripped on last trial.

TEST # 17

17 November 1947
WEIGHT (gross): 2070; (net): 1800

Dist. top of pontoon to w.l. prior blowing	50 ft.	50 ft.	50 ft.	50 ft.
Inflation time	3 m. 35 s.	1 m. 30 s.	1 m. 25 s.	1 m. 15 s.
Time of ascent	19 s.	16 s.	19.5 s.	19 s.
Time required for vent	1 m.			
Time of descent	9.5 s.	Sunk	Sunk	
Appx. max. distance balloon out of water on surfacing.	1 ft.	Sunk	Sunk	

<u>Remarks</u>: A skirt was inserted running from pick up ring along and inside shouds as shown in sketch. It was fitted inside shrouds and secured at every other one. The shrouds were served with marlin to prevent slipping. It is estimated that the opening is about 75% that of the opening without the skirt. No opening in bottom.



Blew air into pontoon when it surfaced.

TEST # 18

17 November 1947

WEIGHT (gross): 1870; (net): 1657

Dist. top of pontoon to w.l. prior blowing	50 ft.	50 ft.	50 ft.	50 ft.
Inflation time	1 m. 25 s.	1 m. 23 s.	1 m. 20 s.	1 m. 20 s.
Time of ascent	10 s.	9.5 s.	10 s.	9.5 s.
Time required for vent	1 m. 15 s.	1 m. 17 s.	1 m. 15 s.	
Time of descent	9 s.	11 s.	9.5 s.	10 s.
Approx. max. distance balloon out of water on surfacing	2 ft.	2 ft.	2 ft.	

TEST # 19

17 November 1947
WEIGHT (gross): 1500; (net): 1325

Dist. top of pontoon to w.l. prior blowing	50 ft.	50 ft.	50 ft.	50 ft.
Inflation time	1 m. 10 s.	1 m. 6 s.	1 m. 4 s.	1 m.
Time of ascent	7.5 s.	8 s.	7 s.	8 s.
Time required for vent	2 m. 5 s.	3 m. 10 s.	2 m. 47 s.	
Time of descent	10 s.	11 s.	10.5 s.	12 s.
Approx. max. distance balloon out of water on surfacing	2 ft.	2.5 ft.	2.5 ft.	

Remarks: Pontoon and bubbles surfaced simultaneously.

TEST # 20

18 November 1947
WEIGHT (gross): 1000; (net): 870

Dist. top of pontoon to w.l. rpior blowing	50 ft.	50 ft.	50 ft.	50 ft.
Inflation time	40 s.	1 m. 14 s.	40 s.	40 s.
Time of ascent	7 s.	7 s.	7 s.	8 s.
Time required for vent		6 m.	6 m.	6 m.
Time of descent	12 s.	13 s.	11.5 s.	13 s.
Approx. max. distance balloon out of water on surfacing	4 ft.	4 ft.	4 ft.	4 ft.
Remarks:	Came almost completely out of water. Little if any air lost	Came out almost completely from water		

TEST # 21

18 November 1947
WEIGHT (gross): 500; (net): 435

Dist. top of pontoon to w.l. prior blowing	50 ft.	50 ft.	50 ft.	50 ft.
Inflation time	23 s.	22 s.	22 s.	24 s.
Time of ascent	10 s.	8 s.	9 s.	8 s.
Time required for vent	4 m. 20 s.	5 m.	5.5 m.	5 m.
Time of descent	15 s.	15 s.	14 s.	12 s.
Approx. max. distance balloon out of water on surfacing	2 1/2 ft.	2.5 ft.	2.5 ft.	2.5 ft.
Remarks: Pontoon not blown clean due to insufficient depth.	Did not jump high out of water.			

TEST # 22

18 November 1947
WEIGHT (gross): 2170; (net): 1900

Dist. top of pontoon to w.l. prior blowing	50 ft.
Inflation time	
Time of ascent	
Time required for vent	
Time of descent	
Approx. max. distance balloon out of water on surfacing.	1/2 ft.
Remarks: Hose tended to wrap itself around line. Lifting line was fastened to pad eye of weight.	Pontoon was overloaded 50 pounds. It was blown until bubbles came up. It could be raised and controlled easily when lift was slow. When lift was fast, control was lost as pontoon tended to gain speed. Then it tended to sink upon surfacing. On surface when being blown, it was easily kept up, due to jet effect. Would sink if light strain were not held.

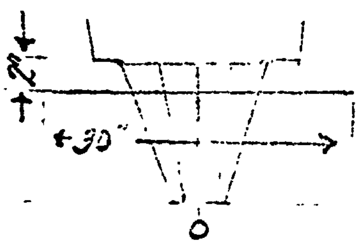
TEST # 23

18 November 1947
WEIGHT (gross): 2045, including plate; (net): 1785

Dist. top of pontoon to w.l. prior blowing	50 ft.	50 ft.	50 ft.	50 ft.
Inflation time	2 m. 25 s.	1 m. 07 s.	1 m. 09 s.	1 m. 10 s.
Time of ascent	16 s.	16 s.	17.5 s.	17 s.
Time required for vent	Sunk	Sunk	Sunk	Sunk
Time of descent	Sunk	Sunk	Sunk	Sunk
Approx. max. distance balloon out of water on surfacing	1 ft.	1 ft.	1 ft.	1 ft.

Remarks:
Plate resting on top of shoud serving about 2" below bottom of pontoon. Plate 30" in diameter 3/16" thickness, from pick up ring to bottom of plate, 64 lbs. under capacity.

Floated after air was blown into it after surfacing.



$$\frac{A^1}{A^2} = \frac{475}{168 + 69} = 2 = 50\ \%\ \text{opening}$$

TEST # 24

2 December 1947
WEIGHT (gross): 2020; (net): 1764

Dist. top pontoon to w.l. prior blowing	50 f.	50f.	50 f.	50 f.	50 f.	50 f.	50f.	50f.
Inflation time	1m22s.	1m10s	1m20s	1m15s	1m8s	1m2s	1m16s	1m12s
Time of ascent	16 s	15 s.	17 s	16 s	19 s	17 s	18 s	17 s
Time req. for vent	Sunk	OK	OK					
Approx.max.distance balloon out of water on surfacing	1 f	1 f	1f	1f	1f	1f	Sunk	Sunk
Time of descent								

Remarks:
Plate rested 4" below bottom of pontoon.

75% of orig. opening.

TEST # 25

3 December 1947
WEIGHT (gross): 2020; (net): 1764

Dist. top of pontoon to w.l. prior blowing	50 ft.	50 ft.	50 ft.	50 ft.
Inflation time	1 m. 14 s.	1 m. 10 s.	1 m. 10 s.	1 m. 10 s.
Time of ascent	17 s.	16 s.	16 s.	16 s.
Time required for vent	Sunk	Sunk	Sunk	Floated
Time of descent	Sunk	Sunk	Sunk	
Approx. max. dist. balloon out of water on surfacing.	1 f.	1 f.	1 f.	1 f.

Remarks: Plate rested 6" below bottom of pontoon. 100% opening.

TEST # 26

3 December 1947
WEIGHT (gross): 1870 lbs. steel, 50 lbs. lead = 1920; (net): 1772

Dist. top of pontoon to w.l. prior blowing	50 ft.	50 ft.	50 ft.	50 ft.
Inflation time	1 m. 14 s.	1 m. 15 s.	1 m. 16 s.	1 m. 15 s.
Time of ascent	11 s.	10.5 s.	13 s.	13 s.
Time required for vent	2 m. 45 s.	2 m.	1 m. 30 s.	
Time of descent	10.5 s.	9 s.	9 s.	
Approx. max. distance balloon out of water on surfacing.	1.5 f.	1.5 f.	2 f.	2 ft.

Remarks:
Just pontoon used; no skirt or plate

Stayed up at all times. At full load bottom of pontoon was 8" along shroud to pick-up ring. Shroud angle with horizontal 60°.